

Attachment 6.1 – Supporting Documents

Monitoring, Assessment and Performance Measures

Madera Region – IRWM Implementation Grant Application

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Attachment 6.1, Comprehensive Projects Performance Measures Table

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Attachment 6.1 - Monitoring, Assessment and Performance Measures

Projects Performance Measures Table

This chart summarizes monitoring, assessment and performance measures for all of the proposed projects:

Project Goals	Outcomes	Output Indicators	Outcome Indicators	Measurement tools	Targets
Project A – Overall Grant Administration					
Timely and complete administration of grant	Successfully completed IRWM Implementation Projects	Invoices submitted in timely fashion with complete backup information	Project deliverables met		Monthly invoices submitted correctly
		Quarterly reports submitted in timely fashion			20 quarterly reports submitted – complete and timely
		Annual reports submitted in timely fashion			5 annual reports submitted – complete and timely
		Final report submitted in timely fashion			Final report submitted – complete and timely
Project B – Ash Slough Arundo Eradication and Sand Removal Project					
Improve flood flows in Ash Slough, reducing flood hazards to the City of Chowchilla and other adjacent properties	<p>Eradicate Arundo from 5 miles of slough, increasing flood flows by 33 percent.</p> <p>Remove 2-3 feet of sand from 5 miles of slough, increasing flood flows by an additional 66 percent</p>	<p>Density of Arundo growth following eradication program</p> <p>Cubic yards of sediment removed</p>	<p>Flood flows (cfs)</p> <p>Flood flows (cfs)</p>	<p>-Arundo monitoring study -Engineering survey and report on channel capacity</p> <p>-Reports by County staff based on sand removal permits/sub-agreements -Engineering survey and report on channel capacity</p>	<p>-95% Arundo eradication in target area -1,000 cfs in increased flood flow capacity over current flows -2 feet of sediment (sand) removed from target area -2,000 additional cfs in increased flood flow capacity</p>
Reduce unnecessary evapotranspiration from <i>Arundo Donax</i> infestation, thereby increasing the amount of agricultural	Eradicate Arundo from 5 miles of slough (90 acres), allowing re-growth of native vegetation which uses	Change in acreage of Arundo in Ash Slough	Decrease of water used for evapotranspiration by slough vegetation	Use of Arundo Et model (direct measurement not possible).	Increase water available for groundwater recharge – qualitative benefit, not specific targets.

Project Goals	Outcomes	Output Indicators	Outcome Indicators	Measurement tools	Targets
water available for beneficial use or groundwater recharge	approximately ½ the water for evapotranspiration				
	Data storage and dissemination	Data stored as part of the Madera County data on Ash Slough, maintained as part of the certification/recertification effort	Data available to public through Team Arundo del Norte web portal	Final report to DWR	Dissemination of Arundo eradication report to 12 organizations, districts, or agencies State-wide
	-Project information disseminated to stakeholders, DWR and Team Arundo del Norte.				
Project C. Cottonwood, Dry, Berenda Creek Arundo Eradication and Sand Removal – Madera Irrigation District					
Improve flood flows in Madera County	Reduction of flood flows that cause property damage and thus economic damage.	Comparison of recorder information prior to the project and post project	Larger flows passing through the downstream-most recorder for the same size storm events	Recorder information-historical and future	Increased flood flows in downstream recorders. Improved flood flows by 75%
Improve Madera County's economic viability by reducing the potential for flood flows	Reduction of flood flows that cause property damage and thus economic damage	Fewer flooding events and thus reduced cost to County residents and taxpayers	Reduce flooding frequency and inundation area for the same size storm events	County and FEMA information regarding flooding along Cottonwood, Berenda and Dry Creek	A savings of \$26,000,000 to Madera County per 10 year storm flood event or larger
Increase water availability in Madera County by reducing unnecessary evapotranspiration from <i>Arundo Donax</i>	Increase the amount of available water by eradicating Arundo which utilizes a tremendous amount of water compared to native vegetation	Determine the amount of Arundo eradicated and calculate the quantity of water saved	Utilize recorder information on the creeks. Determine if with the same flow input, there is increased flow output	GPS data to determine area of Arundo eradicated. Recorder information - historical and future	A savings of approximately 4,075 acre feet per year of ET savings.
Improve wildlife habitat in Madera County along Cottonwood, Dry, and Berenda Creek	Improve wildlife habitat by eradicating Arundo from Cottonwood, Dry, and	Wildlife surveys and water testing	Increased habitat and wildlife sightings. Reduced water temperature	Monitor habitat enhancement through photo monitoring. Wildlife surveys done by consultants	Restore 300 acres of habitat.

Project Goals	Outcomes	Output Indicators	Outcome Indicators	Measurement tools	Targets
	Berenda Creeks thus encouraging native vegetation to be established			(if necessary). Water temperature testing.	
Improve MID's ability to deliver water to its users without capacity constraints	Reduce the obstructions blocking water flow through Cottonwood, Dry, and Berenda Creeks	Comparison of recorder information prior to project and post project.	Larger flows passing through the downstream-most recorder for the same size storm events	Recorder information-historical and future. Flood frequency information from the County	Increase ability to deliver water through the creeks by 20% or 3,000 acre feet and reduce groundwater pumping by 10%
Improve MID's growers' flexibility in managing their water	Increase the amount of water available and improve delivery flexibility	Increased available water	Larger flows passing through the downstream-most recorder for the same storm events	Recorder information-historical and future	Increase available water by approximately 4,075 acre feet per year and improve on-farm system efficiency by 5-10%
D. In-Lieu Recharge Project – Root Creek Water District					
Import Additional Water Supplies	Additional surface water supplies	Amount of imported water	Additional surface water imported to RCWD	Diversion structure flowmeter readings	Import of 6,100 AF annually
Reduce groundwater well pumping	Reduction in pumped groundwater amount	Amount of water pumped	Groundwater Well pumping quantities	Groundwater well pumping logs	Reduction of 6,100 AF per year of pumped groundwater (6,100 AF is the total annual pumping will be displaced with the project)
Reduce local groundwater overdraft	Reduction in groundwater overdraft in RCWD and project vicinity	Amount of water recharged	Groundwater levels within RCWD and project vicinity	Groundwater monitoring of wells to identify groundwater levels.	Eliminate net District overdraft of 3,400 AF per year and provide net in-lieu recharge of 2,700 AF per year, totaling 6,100 AF per year
Make use of flood waters that are sometimes lost to	Recharge flood water that would normally not be able to be	Amount of water recharged	Measurement of water diverted & groundwater levels	Meters installed at turnout, documentation of water	Import annual average of 2,100 AF per year of

Project Goals	Outcomes	Output Indicators	Outcome Indicators	Measurement tools	Targets
Madera County	utilized by Madera County or RCWD		within RCWD and project vicinity	supplied to facility	floodwater
Improve existing groundwater quality	Reduced salinity and other harmful constituents in groundwater	Reduction in negative water quality trend	Groundwater quality within RCWD and project vicinity	Groundwater constituent monitoring	Higher quality groundwater
Minimize flooding damage by diverting some floodwaters	Recharge flood water that would normally not be able to be utilized by Madera County or RCWD	Amount of water recharged	Measurement of water diverted.	Meters installed at turnout, documentation of water supplied to facility	Import annual average of 2,100 AF per year of floodwater
E. Fuel Reduction for Forest Health and Fire Safety – Sierra National Forest					
Reduce the likelihood of high severity wildfires which would remove ground cover that protects soils from excessive erosion and damage the soils ability to filter and retain water	Reduced surface and crown fuel loading	Acres treated	Acres moved to desired fuel model, and crown density.	-Field survey of area treated by GPS - Field survey of fuel models, loads , and crown density	At least 95% of the area meets the contract or project specifications
Minimize the probability of flood events and debris flows occurring after high severity wildfires	Reduced surface fuel loads Maintain sufficient ground cover to protect soils.	Acres treated	Acres moved to desired fuel model Percent ground cover after treatments.	-Field survey of area treated by GPS -Field survey of surface fuel models -Ground cover surveys by transect method	At least 95% of the area meets the contract or project specifications 50-70% ground cover.
Increase overall forest health and resiliency to disturbances, thus preserving and restoring habitat, ecosystems, and hydrologic functions.	Reduced stand and crown density	Acres treated	Acres moved to desired basal area, and crown density.	-Field survey of area treated by GPS -Field survey of stand and crown density	At least 95% of the area meets the contract or project specifications
¹ The desired fuel models stand and crown density are determined by the SNFLRMP and ROD as well as project level NEPA analysis, and vary base on the project location. These are included in the contract or project specifications prior to implementation. Therefore it is not feasible to give a specific density reduction or					

<i>Project Goals</i>	<i>Outcomes</i>	<i>Output Indicators</i>	<i>Outcome Indicators</i>	<i>Measurement tools</i>	<i>Targets</i>
fuel model change as a target for the project. However, meeting contract and project specifications, determined on a site-specific basis and within the guidelines of the SNFLRMP and ROD, will also meet the Project and IRWMP Goals. Please see discussion on Targets below.					

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**Attachment 6.1, Project B – Ash Slough Arundo Eradication and Sand
Removal**

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Project B – Ash Slough Arundo Eradication and Sand Removal

Goals, Objectives and Deliverables

Goals:

- To improve flood flows in Ash Slough, reducing flood hazards to the City of Chowchilla and other adjacent properties
- To reduce unnecessary evapotranspiration from *Arundo Donax* infestation, thereby increasing the amount of agricultural water available for beneficial use or groundwater recharge
- To improve habitat in Ash Slough by eradicating *Arundo Donax*, an invasive exotic plant, and replanting the sloughs with native perennial grasses and other appropriate vegetation.

Objectives:

- Eradicate Arundo from 5 miles of slough, increasing flood flow capacity by 1000 cfs over current capacity.
- Remove 2-3 feet of sand from 5 miles of slough, increasing flood flow capacity by an additional 2000 cfs over current capacity.

Deliverables:

- 95% Arundo eradicated in target 5 miles of Ash Slough
- 2-3 feet of sand removed from 5 miles of Ash Slough
- Flood flows increased by 150%
- Data Monitoring Deliverables:
 - Project specifications, such as the procedures, herbicides, and techniques used for eradication and restoration.
 - the kill rate on the Arundo (output indicator) - Years 1, 2, and 3: percentage Arundo Reduction
 - Sediment removal report
 - Channel surveys to determine increased flow capacity. This can be compared to a HECRAS report done in 2008. (outcome indicator)
- These data will be collected immediately after project completion and three years later to determine the effectiveness and resiliency of the project.
- These data will be stored as part of the Madera County Flood Control and Water Conservation Agency's data on Ash Slough, which is maintained as part of the certification/recertification effort. Information on the techniques used in the project and their success will be disseminated to IRWM participants and stakeholders through the RWMG meetings and reports to the Chowchilla City Council, the Madera County Water Advisory Commission and the Madera County Board of Supervisors. Information will be shared with DWR through its flood control activities. Information will also be forwarded to Team Arundo del Norte, which maintains a portal of information on Arundo and Arundo eradication efforts.

Discussion of Performance Measures

a. The performance measures used to verify project performance include:

- i. Percentage of Arundo eradicated
- ii. Acres of Arundo treated
- iii. Cubic yards of sediment removed
- iv. Dissemination of Reports to appropriate entities within the State.
- v. Increase in flood flow capacity
- vi. Reduced groundwater evapotranspiration from slough vegetation (Qualitative output only).

b. Why 'output indicators' will effectively track program outputs - The 'output indicators' (I. through IV above) are direct measures of the output of the program activities. Indicators I and II which can be measured directly through tested and approved protocols (see #3 below). Indicator III will be measured through the compilation of permits and reports from site observations and Indicator IV will be documented in grant reports. These indicators will therefore effectively track the success of the work done under this grant.

c. Why 'outcome indicators' are adequate to evaluate change resulting from work – The 'outcome indicators' in this case is the increase in flood flow capacity and reduced groundwater evapotranspiration from slough vegetation. Neither of these indicators can be measured directly and will have to be estimated using models. The model for estimating the increase in flood flow capacity is standard engineering protocol.

There are several protocols for estimating the relative evapotranspiration of various plants. At this time no scientifically established evapotranspiration rate for Arundo exists. However the region commissioned a study by UC Santa Barbara faculty to determine the approximate relative and absolute Et rate for Arundo and the most common native slough vegetation. (See Attachment 6.2, page 19) The resulting data and conclusions can be used to estimate the amount of increased groundwater recharge, given the acreage of Arundo removed.

It can be confidently stated that this project will have water supply benefits. However several factors make it difficult to document the exact amount or dollar value of this benefit:

- The acreage of Arundo is an estimate based on observation of several slough transects
- There is not sufficient certainty which kind of native vegetation will re-establish itself after the eradication of the Arundo infestation
- Unlike the Madera Irrigation District's waterways, which are used year round for agricultural water deliveries, the Ash Slough is dry for several months of the year. It is difficult to claim that waters from the slough would otherwise percolate into the groundwater during these dry months.

For this reason, this project is not claiming quantitative water supply benefits for this project. There will be definite benefits, but they can only be described in a qualitative manner.

d. Where and when data will be collected – Data which can be directly collected will be obtained on the following schedule:

- I. Percentage of Arundo eradicated – Arundo eradication data will be collected in March or April each year after spraying and mulching per the standard monitoring protocols for invasive species research (see 3 below).
- II. Acres treated – Collected during treatments by County staff overseeing project.
- III. Cubic yards of sediment removed – This information will be submitted on the landowner agreement/sup-permits and confirmed by spot inspections of County staff.

e. Why it is feasible to meet targets within the life of the proposal. – The targets of the proposed activities are based on credible assessments, research and protocols. The timelines follow these protocols, and have taken into consideration potential delays.

Discussion of monitoring system(s)

a. Arundo Eradication and survival rate of revegetated native plants – The monitoring program will follow the Team Arundo del Norte Arundo Eradication and Coordination Program Surveying and Monitoring Protocol. (See Attachment 6.2, page 3). This is a complete data collection and management system approved by Team Arundo for standardized collection and reporting of information, including initial site surveys, treatment information and follow-up changes in plant communities.

The monitoring of Arundo eradication will utilize GeoWeed, a geospatially enabled data collection and management tool for invasive plant project managers¹. GeoWeed is open source software which allows the weed manager and their field crews to record locations of invasive (or any) plants for early detection and management. Plant population sizes and locations may be tracked over time to monitor change using GPS points or polygons. Treatments and labor can optionally be tracked with a choice of granularity level. GeoWeed uses a superset of the NAWMA weed mapping standard, and contains mostly a superset of the data collected in TNC-WIMS.

GeoWeed is primarily for those involved in efforts to fight invasive plants and weeds. It can also be used to track non-weed plants, and in particular has been used to record and map locations of protected plants. It will therefore be an effective monitoring protocol to measure Arundo eradication and impact on protected plants. For more information, see Attachment 6.2, page 7 and Attachment 6.2, page 13.

¹ The monitoring protocol information provided refers to the Weed Information Management System (WIMS) as the data collection and management tool. This has been updated by the development of the GeoWeed tool, which is a subset of WIMS.

b. Channel surveys – The increased flood flows resulting from the sediment removal will be documented through monitoring of the sand removal activities. This will take place through compilation of information from the permits and from inspections done by County engineering staff.

Consistency with Basin Plan

This project is designed to be consistent with the basin plan for the San Joaquin Basin. The Project Proponents have coordinated with RWQCB staff and determined that consistency with the Basin Plan will be the result of utilizing best management practices in fulfilling the requirements of the permits (DFG 1602, 401 and 404 permits for sediment removal, SWPPP, etc.), once those permits have been issued and the requirements and conditions set forth.

How monitoring data will be used to measure the performance of the IRWM Plan

The following goals of the Madera Region IRWM can be furthered by the implementation of this project.

- Incorporate flood protection into the water management strategy
- Substantially reduce or eliminate the current groundwater overdraft through improved management of existing water supplies and development of additional water supplies.
- Assess the potential for conservation, wastewater reuse/recycling, and watershed management.

The monitoring data from this project provides the following information to measure these goals:

- Quantitative data showing the increase in flood flow capacity protecting high-density residential area from flood hazards
- Quantitative information on Arundo eradication allowing a qualitative estimate of the increase on water for groundwater recharge, reducing the area's extreme groundwater overdraft.
- Quantitative information on reduction in infestation by non-native invasive vegetation on 5 miles of slough, improving watershed conditions for riparian species, including sensitive species.

**Attachment 6.1, Project C – Cottonwood Creek, Dry Creek, and Berenda
Creek Arundo Eradication and Sand Removal**

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Project C – Cottonwood, Dry and Berenda Creek Arundo Eradication and Sand Removal

Project Goals and Objectives

Madera Irrigation District (MID or the District) is seeking IRWM grant funding to assist the District in Arundo eradication and sediment removal in the three main creeks that run through the District. The District's goal and objectives are as follows:

Goals:

- To improve flood flows in Madera County. Specifically on property, both industrial and agricultural, along Cottonwood Creek, Dry Creek and Berenda Creek
- To improve Madera County's economic viability by reducing the potential for flood flows
- To increase water availability in Madera County by reducing unnecessary evapotranspiration from *Arundo Donax* infestation
- To improve wildlife habitat in Madera County along Cottonwood Creek, Dry Creek and Berenda Creek by eradicating *Arundo Donax*, an invasive exotic plant, and by removing excess sedimentation.
- To improve Madera Irrigation District's ability to deliver water to its users without capacity constraints.
- To provide Madera Irrigation District's growers greater flexibility in managing their water, thus improving overall irrigation efficiency and use.

Objectives:

- Eradicate Arundo from 32 miles of creeks and an area of approximately 300 acres.
- Remove 25,000 tons of sand from 32 miles of creek bottom.

Deliverables:

- Flood flows increased by 75%
- Restore habitat by 300 acres
- Increase available water by 4,075 acre feet per year from evapotranspiration savings.
- Data Monitoring Deliverables:
 - Project specifications, such as the procedures, herbicides, and techniques used for eradication and restoration.
 - The kill rate on the Arundo (output indicator) - Years 1, 2, and 3: percentage Arundo Reduction
 - Sediment removal report
- These data will be collected immediately after project completion and three years later to determine the effectiveness and resiliency of the project.
- Information on the techniques used in the project and their success will be disseminated to IRWM participants and stakeholders through the RWMG meetings and reports to the Madera Irrigation District Board of Directors. Information will be

shared with DWR through its flood control activities. Information will also be forwarded to Team Arundo del Norte, which maintains a portal of information on Arundo and Arundo eradication efforts.

Performance Measures

The performance measures MID will use to evaluate the effectiveness of the project will consist of a wide range of measurement techniques for both Arundo Eradication and Sediment Removal.

1. Arundo Eradication

MID will map existing Arundo in the field using a handheld Global Positioning System (GPS) and high quality aerial photos. This will be done before the project begins and each subsequent year to determine the success of the project. This information will be mapped on ArcGIS and comparisons made year to year and area to area. If it is determined that the kill rate is not at optimal, MID will address the progress of the project.

MID will also develop a photo documentation study. MID will set up photo monitoring locations along each creek. At distinct time intervals MID will photo document the creek to determine if the Arundo removal is successful and the effects on native vegetation and habitat.

2. Arundo and Sediment Removal

MID has collected flood data on each of the three creeks, Cottonwood Creek, Dry Creek, and Berenda Creek, since 1966. MID collects flood data in the upper reaches near where it enters the District and in the lower reaches where it exits the District. MID will be able to compare recorded flows during each year of the project and compare this information to prior years to determine if additional flows are reaching the lower reaches of the creeks. An analysis can be done to compare the amount of flows at each location for each storm event before, during, and after the project to determine the effect of the project on these creeks. Refer to Attachment 6.3, page 3, for the Recorder Location Maps.

3. Sediment Removal

MID will be able to calculate the volume of sediment removed from each creek. Increased flow estimates can be derived using this information along with other channel information such as cross section, slope, existing vegetative cover, etc.

It is feasible to meet these targets within the life of the proposal. MID has the staff and access to the required equipment to eradicate Arundo and remove sediment. MID has field personnel that frequently travel these creek corridors. The field personnel will be trained on identifying Arundo and will notify management if problem areas arise. This will allow MID to eliminate the problem areas in a timely manner, thus helping ensure the targets are met within the timeframe.

Also, MID will work with adjacent landowners in educating them about Arundo and how to identify it. MID will encourage adjacent landowners to report Arundo to the District if any is found in or near MID facilities. This will create another level of oversight in the eradication process.

Basin Plan

This project is designed to be consistent with the basin plan for the San Joaquin Basin. The Project Proponents have coordinated with RWQCB staff and determined that consistency with the Basin Plan will be the result of utilizing best management practices in fulfilling the requirements of the permits (DFG 1602, 401 and 404 permits for sediment removal, SWPPP, etc.), once those permits have been issued and the requirements and conditions set forth.

How Monitoring Data will be used to measure performance in meeting IRWM Plan Goals

The following goals of the Madera Region IRWM can be furthered by the implementation of this project.

- Incorporate flood protection into the water management strategy
- Substantially reduce or eliminate the current groundwater overdraft through improved management of existing water supplies and development of additional water supplies.
- Assess the potential for conservation, wastewater reuse/recycling, and watershed management.

The monitoring data from this project provides the following information to measure these goals:

- Quantitative data showing the increase in flood flow capacity protecting rural residences from flood hazards
- Quantitative information on Arundo eradication allowing an estimate of the increase on water for groundwater recharge, reducing groundwater overdrafts using a credible model developed for the region.
- Quantitative information on reduction in infestation by non-native invasive vegetation on 5 miles of slough, improving watershed conditions for riparian species, including sensitive species.

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Attachment 6.1, Project D – Root Creek In-Lieu Groundwater Recharge

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Project D – Root Creek In-Lieu Groundwater Recharge

Project Performance Measures for the project are discussed below. Groundwater level monitoring is already in place by RCWD. RCWD will continue the ongoing groundwater monitoring efforts during the project and afterwards to evaluate the success of the project. Project performance measures include monitoring pipeline/diversion structure flows, and groundwater well pumping.

Project Performance Measures

The stated performance measures can all be measured using currently accepted standards. Groundwater elevation and constituent monitoring can be done using existing wells within RCWD and the surrounding areas. Surface water diversions will be measured using the proposed flowmeter at the new turnout. The recharge quantities and reduction of groundwater pumping are measured by both the amount of diverted imported surface water and groundwater levels in wells in RCWD and surrounding areas. The reduction in pumping costs is easily determined by comparing the electrical requirements based on normal irrigation cycles.

Basin Plan Consistency

The GWMP adopted by RCWD is consistent with the Basin Plan. The GWMP calls for the reduction and mitigation of the existing basin's current groundwater overdraft through reduced groundwater pumping and use.

Project Groundwater Monitoring Program

There are three pieces to the groundwater-monitoring program.

The first piece of the program is to continue collecting and organizing the pumpage records for irrigation and domestic wells in RCWD. These records have been collected and evaluated by RCWD for over 15 years. The second piece of the program is to semi-annually measure groundwater levels in the same wells that RCWD performs water quality testing on. The third piece of the monitoring program is an annual measurement of electronic conductivity (EC) in the wells. These wells are shown in Attachment 6.4, page 3. The EC test is a general measure of groundwater quality. If a drastic change occurs, further in-depth testing will be performed.

Additionally, the records of the surface water delivered to RCWD will be used, in conjunction with actual groundwater pumping data from the wells within RCWD, to determine the amount of groundwater pumping that was avoided.

Since RCWD has a GWMP in place, all sampling and reporting will follow the formats already established in the GWMP. In addition, RCWD and three neighboring Water Districts have recently prepared a draft MOU entitled "Madera-Chowchilla Basin Regional Groundwater Monitoring Plan". This document will guide regional groundwater monitoring efforts.

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Attachment 6.1, Project E – Sierra National Forest Fuel Reduction

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Project E – Sierra National Forest Fuels Reduction Project

Project Goals

The overall goals of the fuel reduction project are:

- Reduce the likelihood of high severity wildfires which would remove ground cover that protects soils from excessive erosion and damage the soils ability to filter and retain water
- Minimize the probability of flood events and debris flows occurring after high severity wildfires
- Increase overall forest health and resiliency to disturbances, thus preserving and restoring habitat, ecosystems, and hydrologic functions.

These goals will be met by reducing fuel loads and tree density in overstocked (unnaturally dense) stands. The fuel reduction goals can be measured immediately following the treatments. The flood and debris flow protection is also realized immediately since the reduced fuels will decrease the extent and severity of a wildfire. However, some of the goals will not immediately be met because time will be required for the land to respond to the treatment. For example, thinning creates greater forest heterogeneity by partially opening the forest canopy to allow greater sunlight penetration to the forest floor. This in-turn promotes more variability in tree species and ages as well as promotes greater herbaceous and shrub growth and age classes particularly through the first 10-20 years following treatments. It is impractical to design a monitoring and assessment protocol to be done 10-20 years in the future to assess ecosystem restoration. The monitoring and assessment of this goal is embedded within that of the stand density and fuel load.

Monitoring Locations

Monitoring and assessment of stand conditions will be done in each unit that is thinned by the contract inspector or work leader.

Soil cover monitoring will be done by either a soil scientist or hydrologist in each stand that is thinned.

Performance Measures, Output Indicators, and Outcome Indicators:

Project performance will be measured using field surveys and contractor work inspections. Acres treated are surveyed using a GPS after treatment with a 2% margin of error. Contract inspectors (for contracts) and work leaders (for in-house work) will conduct on the ground inspections of stand conditions during and after treatment to ensure that outcome indicator targets are being met. The results of these inspections are reported in internal databases and will also be included in the quarterly and annual reports to the Grant Administrator. Since the goals of this project are embedded in fuel loading and stand density, these will be the primary outcome indicators. Fuel loading will be measured using the Intermountain Fire Science Laboratory (IFSL) Thirteen Standard

Fuel Models (Andersen 1982). As an example, Table 1 shows the fuel models for the Cedar Valley area and their related fire behavior under average conditions (USDA 2007).

Table1-Comparison of the existing ground and surface fuel conditions and the associated average fire behavior characteristics within the Cedar Valley project area.

IFSL FUEL MODEL	AVERAGE FUEL LOADING FOR FUEL MODEL (TONS/ACRE)	AVERAGE RATE OF SPREAD (CHAINS/HOUR)	AVERAGE FLAME LENGTH (FEET)
2	4	35	6
4	13	75	19
5	3.5	18	4
6	6	32	6
8	5	1.6	1
9	3.5	7.5	3
10	12	7.9	5

Crown fuels are typically assessed using crown density, which gives an indication of the potential for fire to spread from one crown to another (active crown fire).

Soil cover retention is prescribed based on slope and soil erodability. In general, for highly erosive soils on steep slopes, typical ground cover requirements are at least 70%. For gentler slopes with less erodible soils, a ground cover of 50% is allowed. The exact requirements are developed by the soils scientist during the NEPA process.

Targets

The Sierra National Forest is required to complete vegetation management projects in conformance with the Standards and Guidelines (S&Gs) contained within the Sierra National Forest Land and Resource Management Plan (SNFLRMP, USDA-FS 1995) as amended by the Sierra Nevada Forests Record of Decision (ROD, USDA-FS 2004). These S&Gs vary for different land allocations. The land allocations and requirements for these projects include:

Wildland Urban Intermix (WUI) Defense Zones (USDA-FS 2004; pg 40):

- Stands are fairly open and dominated primarily by larger, fire tolerant trees.
- Surface and ladder fuel conditions are such that crown fire ignition is highly unlikely.
- The openness and discontinuity of crown fuels, both horizontally and vertically, result in very low probability of sustained crown fire.

WUI Threat Zones (USDA-FS 2004; pg 41) should, under high fire weather conditions, in treated areas display wildland fire behavior characterized as follows:

- Flame lengths at the head of the fire are less than four feet;
- The rate of spread at the head of the fire is reduced to at least 50 percent of pre-treatment levels;
- Hazards to firefighters are reduced by managing snag levels in locations likely to be used for control prescribed fire and fire suppression consistent with safe practices guidelines;
- Production rates for fireline construction are doubled from pre-treatment levels; and
- Tree density has been reduced to a level consistent with the site's ability to sustain forest health during drought conditions.

Outside WUI areas, fuel reduction treatments in plantations are to be designed to achieve the following standards (USDA-FS 2004; pg 50):

- 3 inches and smaller surface fuel load: less than 5 tons per acre,
- less than 0.5 foot fuel bed depth,
- stocking levels that provide well-spaced tree crowns (for example, approximately 200 trees per acre in 4 inch dbh trees),
- less than 50 percent surface area with live fuels (brush), and
- tree mortality less than 50 percent of the existing stocking under 90th percentile fire weather conditions

Mechanical Thinning outside WUI areas in mature forest (USDA-FS 2004; pgs 50-51):

- Design projects to retain at least 40 percent of the existing basal area. The retained basal area should generally be comprised of the largest trees.
- Where available, design projects to retain 5 percent or more of the total treatment area in lower layers composed of trees 6 to 24 inches dbh within the treatment unit.
- Design projects to avoid reducing pre-existing canopy cover by more than 30 percent within the treatment unit. Percent is measured in absolute terms (for example, canopy cover at 80 percent should not be reduced below 50 percent.)
- Within treatment units, at a minimum, the intent is to provide for an effective fuels treatment. Where existing vegetative conditions are at or near 40 percent canopy cover, projects are to be designed remove the material necessary to meet fire and fuels objectives.
- Within California spotted owl Home Range Core Areas: Where existing vegetative conditions permit, design projects to retain at least 50 percent canopy cover averaged within the treatment unit. Exceptions are allowed in limited situations where additional trees must be removed to adequately reduce ladder fuels, provide sufficient spacing for equipment operations, or minimize re-entry. Where 50 percent canopy cover retention

cannot be met for reasons described above, retain at least 40 percent canopy cover averaged within the treatment unit.

- Outside of California spotted owl Home Range Core Areas: Where existing vegetative conditions permit, design projects to retain at least 50 percent canopy cover within the treatment unit. Exceptions are allowed where project objectives require additional canopy modification (such as the need to adequately reduce ladder fuels, provide for safe and efficient equipment operations, minimize re-entry, design cost efficient treatments, and/or significantly reduce stand density.) Where canopy cover must be reduced below 50 percent, retain at least 40 percent canopy cover averaged within the treatment unit.
- Within California spotted owl PACs, where treatment is necessary, remove only material needed to meet project fuels objectives. Focus on removal of surface and ladder fuels.

More site-specific requirements are developed during the project level NEPA analysis but are within those discussed above. Requirements from the SNFLRMP, ROD, and those that are developed during the NEPA process are included in the project and contract specifications. By meeting the project and contract specifications, these projects will also meet the goals of the Madera Region IRWMP by reducing the probability of uncharacteristic wildfire which could result in increased flooding and debris flows, loss of habitat, and reduction in water quality.